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ZORA URL: <https://doi.org/10.5167/uzh-64371>

Journal Article

Published Version

Originally published at:

Jeffery, S; Knechtle, B; Rüst, C A; Knechtle, P; Rosemann, T; Lepers, R (2012). European dominance in Triple Iron ultra-triathlons from 1988 to 2011. *Journal of Science and Cycling*, 1(1):30-38.

European dominance in Triple Iron ultra-triathlons from 1988 to 2011

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Abstract

The aims of this study were (i) to investigate the participation in Triple Iron ultra-triathlons covering 11.4 km swimming, 540 km cycling, and 126.6 km running between 1988 and 2011 and (ii) to analyze the nationalities of the athletes achieving the fastest swimming, cycling, running and overall race times. Six out of seven races worldwide were held in Europe. Participation of male Triple Iron ultra-triathlons increased over the 24-year period while the participation of females remained stable at ~8% of the total field. Out of the 1,258 participants, 1,077 athletes (85.6%) originated from Europe. The number of male European athletes ($r^2 = 0.23$; $P = 0.02$) and male North American athletes ($r^2 = 0.35$; $P < 0.01$) increased across years. European males (2.161 ± 168.5 min) were faster ($P < 0.05$) than both European females (2.615 ± 327.2 min) and North American males (2.850 ± 370.6 min). Male European athletes improved ($r^2 = 0.18$; $P = 0.043$), while European females impaired ($r^2 = 0.48$; $P = 0.001$) overall race time. To summarize, participation in Triple Iron ultra-triathlon increased across years where most of the participants originated from Europe. European males achieved the fastest overall race times and improved their performance across years. Future studies need to investigate what motivates these athletes to compete in these races.

Keywords: swimming, cycling, running, ultra-endurance, performance

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Received: 2 March 2012. Accepted: 27 June 2012.

Introduction

Triathlon is a multi-sports discipline consisting of swimming, cycling and running (Ackland et al. 1998). Several triathlon race distances exist such as the Olympic distance triathlon (1.5 km swimming, 40 km cycling, and 10 km running), the Ironman distance triathlon (3.8 km swimming, 180 km cycling, and 42 km running), and distances longer than the Ironman triathlon such as the Double Iron ultra-triathlon (7.6 km swimming, 360 km cycling, and 84.4 km running), the Triple Iron ultra-triathlon (11.4 km swimming, 540 km cycling, and 126.6 km running), and the Deca Iron ultra-triathlon (38 km swimming, 1,800 km cycling, and 422 km running). Among the ultra-distances, competing in Triple Iron ultra-triathlons seems of increasing interest (Knechtle et al. 2007; 2008b; 2010; 2011a; 2011d; 2011e). Compared to an Ironman triathlon with a mean race time of $\sim 689 \pm 79$ min, finishing a Triple Iron ultra-triathlon requires a mean race time of $\sim 2,811 \pm 379$ min (Knechtle et al. 2011e).

Although the Triple Iron ultra-triathlon is only three times the distance of an Ironman, it needs the athletes to compete for about four times the race time of an Ironman triathlon.

The first ever Triple Iron ultra-triathlon was held in Le Fontanil (France) in 1988, where 11 male competitors entered (Knechtle et al. 2011a). The first female ultra-triathlete started in 1989 in a Triple Iron ultra-triathlon. Since 1988, there have been races held over the Triple Iron ultra-triathlon distance in Germany (Lensahn), Great Britain (Lichfield and The New Forrest), Austria (Moosburg and Neulengbach) and in the USA (Virginia) (www.iutasport.com). A total of 1,071 female and male athletes competed in those races up to 2009 (Knechtle et al. 2011a).

Previous studies conducted on ultra-endurance sport investigated nutrition (Robins 2007), predictors of performance (Lepers et al. 2011; Knechtle et al. 2011b; 2011c), pre-race experience (Knechtle et al. 2011b), age and gender interactions in performance (Lepers and Maffiuletti 2011), and pacing strategies (Herbst et al. 2011). For ultra-distances in triathlon such as a Triple Iron ultra-triathlon, it has been shown that low body fat was associated with faster race times (Knechtle et al. 2008a). It has also been evidenced that running and cycling performance (Knechtle et al. 2007; Knechtle and Kohler 2009) as well as the personal best time in an Ironman triathlon and in a Triple Iron ultra-triathlon (Knechtle et al. 2011d) were related to overall Triple Iron ultra-triathlon race times.



The participation and performance trends of ultra-endurance athletes such as ultra-marathoners (Hoffman et al. 2010; Hoffman and Wegelin 2009) and Ironman triathletes (Lepers 2008; Lepers and Maffiuletti 2011) have already been investigated. Participation and performance trends in ultra-triathlons from 1985 to 2009 have also been described (Knechtle et al. 2011a; Lepers et al. 2011). However, little is known about the nationalities of these athletes. Rüst et al. (2012a) showed that the Double Iron ultra-triathlon distance was dominated by European triathletes regarding participation as well as overall performance. For other endurance disciplines such as running, a dominance of a specific ethnicity has been shown (Donnelly 2000; Larsen 2003; Onywera et al. 2006; Onywera 2009; Weston et al. 1999). Kenyan runners are dominating the marathon running scene and are originating from a very distinctive environmental background in terms of geographical distribution. Most national and international athletes came from the Rift Valley province and belonged to the Kalenjin ethnic group and Nandi sub-tribe (Onywera et al. 2006).

Competing in a Triple Iron ultra-triathlon is generally the last step before entering the ultimate ultra-triathlon challenge consisting in a Deca Iron ultra-triathlon. Recently, Lepers et al. (2011) showed that mainly European athletes had completed in all a Double Iron ultra-triathlon, a Triple Iron ultra-triathlon and a Deca Iron ultra-triathlon. With respect to the Double Iron ultra-triathlon, it would be of interest to analyse how the participation and performance trends in Triple Iron ultra-triathlon developed over the last two decades, with special emphasis on the localization of the races and the nationalities of finishers and top athletes.

The aims of this study were (i) to investigate the changes in participation in Triple Iron ultra-triathlon between 1988 and 2011 and (ii) to analyse the nationalities of the athletes who achieved the fastest swimming, cycling, running and overall race times. It was hypothesized (i) that the participation in Triple Iron ultra-triathlons increased over the studied period following the general trends of ultra-endurance sports. Since European athletes dominated Double Iron ultra-triathlons (Rüst et al. 2012a), we hypothesized (ii) that Europeans also dominated the Triple Iron ultra-triathlon races worldwide.

Materials and methods

Data from all athletes who participated at least once in a Triple Iron ultra-triathlon worldwide between 1988 and 2011 were analysed regarding participation and performance related to origin and gender of the athlete. The data set from this study was obtained from the race directors and the IUTA (International Ultra-Triathlon Association) (www.iutasport.com). The study was approved by the Institutional Review Board of St. Gallen, Switzerland, with waiver of the requirement for informed consent given that the study involved the analysis of publicly available data. The study meets the ethical standards of the journal (Harriss and Atkinson, 2011).

In 1988, the first Triple Iron ultra-triathlon took place in Le Fontanil (France). The race was held annually until 2001, apart from the years 1993 and 1999. From 1992 on, a further Triple Iron ultra-triathlon was held in Lensahn (Germany). Since 2010, there was one more race organised in Lichfield (Great Britain). Other Triple Iron ultra-triathlons were also held in Austria, such as the race in Moosburg in 2006 and 2007, and Neulengbach from 1996 to 2000. In 2011, a further race was organised in The New Forest (Great Britain). Virginia in USA is the only place outside of Europe holding a Triple Iron ultra-triathlon. The race director in Virginia started organising the races in the year 2000 and held them annually, with the exception of the year 2003. Lensahn (Germany) and Virginia (USA) are the two locations where the races are still organised to date.

Data analysis

In total, data were available from 1,259 athletes, including 97 females and 1,162 males. The athletes originated from all continents (i.e. Asia, Australia, Europe, North America and South America) and 31 different countries. For two male athletes, no information about country or continent of origin was given and thus they were excluded from analysis. Among the remaining 1,257 athletes, 20 females and 310 males did not finish the race. For the analysis of the number of competitors per year, per country and per continent, as well as the development of the number of triathletes per year, all athletes, independently from their success (i.e. finisher or non-finisher) were considered in the analysis. For the calculation of the cumulative number of wins per continent, in every year the total number of victories was counted for every continent. To investigate the annual development of the top performance per continent, the fastest overall race times as well as the fastest split times in swimming, cycling and running were determined annually for every continent. Due to the very small number of participants per year and continent, an analysis was possible for males from Europe and North America and for females from Europe. For athletes originating from the other continents, not enough data were available to perform an appropriate analysis.

Statistical analyses

In order to increase the reliability of the data analyses, each set of data was tested for normal distribution as well as for homogeneity of variances in advance of statistical analyses. Normal distribution was tested using a D'Agostino and Pearson omnibus normality test and homogeneity of variances was tested using a Levene's test in the case of two groups and with a Bartlett's test in the case of more than two groups. To compare two groups with normal distribution and equal variances, a Student's *t*-test was used. To compare two groups with not normal distribution but equal variances, the Mann-Whitney test was applied. In the case of not equal variances, an unpaired test with Welch's correction was used. To compare more than two groups with normal distribution, a one-way analysis of variance (ANOVA) with Tukey-Kramer

post-hoc test was applied. Non-parametric data were analyzed using a Kruskal-Wallis test with Dunn's post hoc test in the case of not normal distribution. To find significant changes in a variable across years, linear regression was used. Statistical analyses were performed using IBM SPSS Statistics (Version 19, IBM SPSS, IL, USA) and GraphPad Prism (Version 5, GraphPad Software, CA, USA). Significance was

Table 1. Distribution of the nationalities of the finishers sorted by continent.

Continent of origin	Females	Males	Total
Asia	6.2%	0.7%	1.1%
Australia		0.6%	0.6%
Europe	67.0%	87.1%	85.5%
North America	16.5%	11.0%	11.4%
South America	10.3%	0.6%	1.4%

accepted at $P < 0.05$ (two-sided for t-tests). Data in the text are given as mean \pm standard deviation (SD).

Results

Participation trends

Among the 1,259 starters in Triple Iron ultra-triathlons, 919 athletes (73%) finished. For the 97 female starters, 20 athletes (21%) did not finish and within the 1,162 male starters, 310 participants (27%) did not reach the finish line.

Athletes from different continents such as Europe, North America, South America and Asia started in the races (Table 1). Among the 1,258 male and female participants, 1,077 athletes (85.6%) originated from Europe (Table 2). The participation in the different events across years is shown in Table 3. Table 4 shows the total number of participants and their country of origin for the different Triple Iron ultra-triathlons. No African athletes ever participated in a Triple Iron ultra-triathlon. The races in Le Fontanil (France) and

Lensahn (Germany) attracted participants from more countries than other races. The host country was generally the country providing the most athletes for the race.

The participation in Triple Iron ultra-triathlon increased across years. From 1988 to 2011, the number of female participants in the Triple Iron ultra-triathlon remained stable at ~8%. There was no change in the total number of female participants from the four different continents across years ($P > 0.05$). The number of male athletes increased across years for athletes from Europe ($r^2 = 0.23$; $P = 0.02$) and North America ($r^2 = 0.35$; $P < 0.01$)

Table 2. Distribution of the nationalities of the finishers by country, sorted in alphabetical order.

Country of origin	Females	Males	Total
Austria	4.6%	9.3%	9.0%
Belgium		0.5%	0.5%
Croatia		0.4%	0.4%
Czech Republic	3.1%	0.6%	0.7%
Denmark		3.6%	3.3%
France	3.1%	21.2%	20.1%
Great Britain	7.7%	6.9%	7.0%
Germany	61.5%	35.4%	37.0%
Hungary	1.5%	4.2%	4.0%
Ireland	1.5%	0.8%	0.8%
Italy		3.2%	3.0%
Latvia		0.5%	0.5%
Lithuania		1.4%	1.3%
Luxembourg		0.5%	0.5%
Netherlands		2.7%	2.5%
Norway		0.2%	0.2%
Poland		0.4%	0.4%
Portugal		0.1%	0.1%
Russia		1.0%	0.9%
Slovenia		0.2%	0.2%
Spain		0.7%	0.6%
Switzerland	16.9%	5.7%	6.4%

Table 3. Number of participants (finishers and non-finishers) over the years in all Triple Iron ultra-triathlons worldwide.

Year	Moosburg (Austria)	Neulengbach (Austria)	Fontanil (France)	Lichfield (Great Britain)	Lensahn (Germany)	Virginia (United States of America)	The New Forest (Great Britain)
1988			11				
1989			8				
1990			28				
1991			27				
1992			56		9		
1993					17		
1994			37		24		
1995			43		23		
1996		10	29		18		
1997		8	40		20		
1998		16	26		21		
1999		20			13		
2000		10	21		30	7	
2001			22		33	4	
2002					24	5	
2003					38		
2004					26	12	
2005					28	11	
2006	29				24	9	
2007	6				43	18	
2008					53	11	
2009					41	13	
2010				22	45	4	
2011					45	15	11

(Figure 1). For male athletes from Asia, Australia or South America, no change in participation was observed ($P > 0.05$).

Performance trends

The mean finisher rate was at ~75% (Figure 2). European athletes achieved a greater number of successful finishes than North American athletes. The race with the highest percentage of finishers was the race in Virginia (USA). North American athletes reached a high number of successful finishes in The New Forrest (Great Britain), and only very few finishes in Neulengbach (Austria). Despite South America provided a small number of participants, they achieved a high percentage of successful finishes in most of the competitions. The exception was the race in Le Fontanil (France), where little more than half of the South American competitors finished the race. During the 24 years, only European and North American athletes ever won a Triple Iron ultra-triathlon (Figure

Table 4. Number of male and female participants per country during the studied period for the different Triple Iron ultra-triathlons.

Country of Origin	Moosburg	Neulengbach	Fontanil	Lichfield	Lensahn	Virginia	The New Forest
Japan			2		2		
Singapore					4		
Australia			7				
Austria	22	13	21		38		
Belgium			4		1		
Croatia	2				2		
Czech Republic			2		3	1	
Denmark		1	12		23		
Spain			1		6		
France	3	6	159		44	3	
Great Britain		1	8	22	21	7	11
Germany	2	23	24		304	5	
Hungary	1	1	14		25	1	
Ireland	1	1	3		3		
Italy	1		5		18	8	
Latvia		1	4				
Lithuania		3	7		4		
Luxembourg					5		
Netherlands		1	14		12		
Norway					2		
Poland			2		2		
Portugal			1				
Russia		3	4		3		
Slovenia	1				1		
Switzerland	2	7	15		26	8	
Sweden					7		
Canada		1	12		2		
USA		2	22		14	75	
Argentina			1				
Brazil			2		3	1	

3). European athletes achieved more than 48 victories, all of them won by male athletes in the 1988 to 2011 time period, which was considerably higher than the seven victories obtained by North American triathletes. No athlete originating from Asia, South America or Australia ever won a Triple Iron ultra-triathlon.

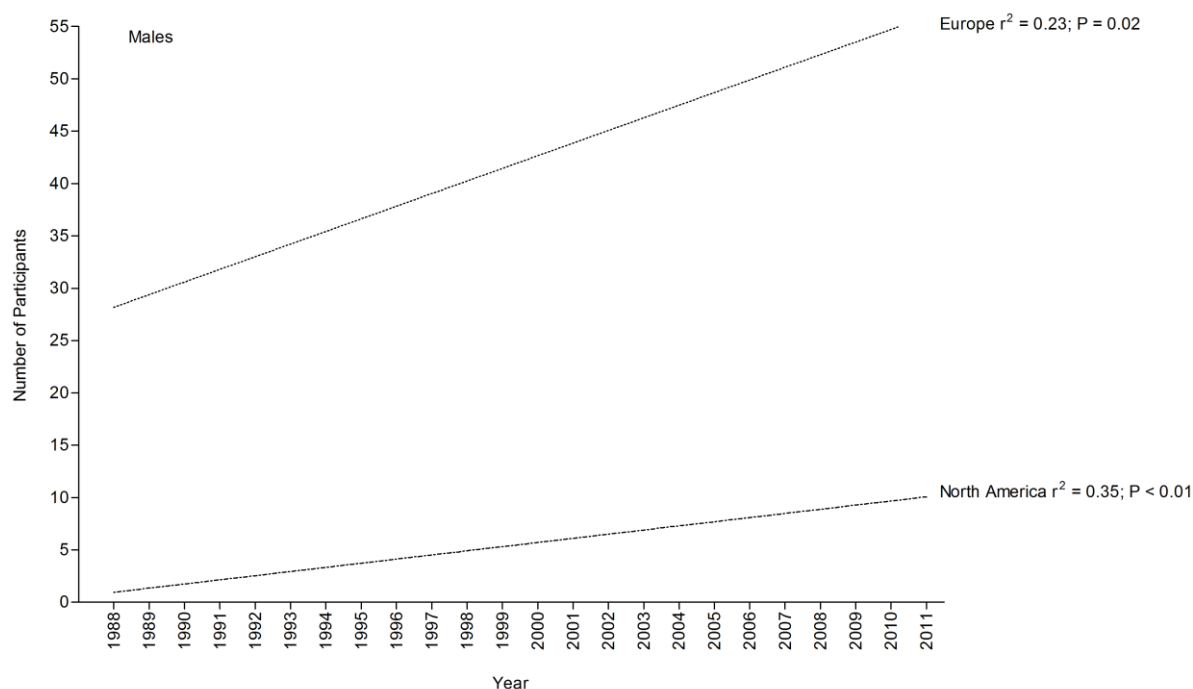


Figure 1. Changes in the number of male participants per continent (1988-2011).

Figure 4 presents the changes in performance across years. Male North American triathletes showed no change in performance ($P > 0.05$). European males, with a total race time of 2.161 ± 168.5 min, were significantly faster than both European females, with a race time of 2.615 ± 327.2 min, and North American males with 2.850 ± 370.6 min ($P < 0.05$). European males also improved their overall race time across years ($r^2 = 0.20$, $P = 0.03$) (Figure 4 Panel A). In swimming, only European males ($r^2 = 0.17$; $P = 0.04$) improved their performance (Figure 4 Panel B). They were, with 180.8 ± 19.8 min, highly significantly faster than both European females, with 230.6 ± 21.8 min, and North American males with 221.2 ± 40.5 min, respectively ($P < 0.01$). In cycling, European males improved their split time ($r^2 = 0.30$; $P < 0.01$) (Figure 4 Panel C), whereas European females became slower. European males achieved split times in cycling of 1.085 ± 83.7 min, and were faster than European females who achieved

cycling split times of 1.313 ± 135.3 min ($P < 0.05$). European males were also faster than North American males with 1.443 ± 232.1 min ($P < 0.05$). In running, European females showed a significant decrease in performance ($P < 0.05$), whereas the split time in running for both European and North American males remained unchanged (Figure 4 Panel D). European

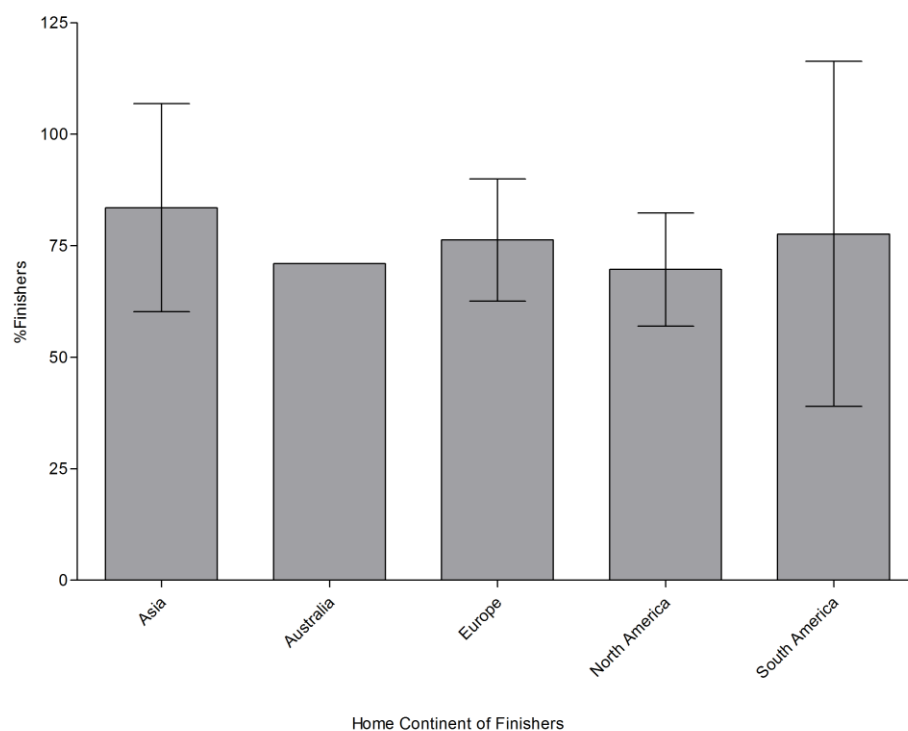


Figure 2. Relative amount of finishers by continent in relation with the localization of the event (1988-2011).

males completed the run split within 788 ± 71.9 min, and were significantly faster than both European females with 1.032 ± 218.4 min and North American males with 1.132 ± 170.9 min ($P < 0.05$).

Discussion

Participation trends

The first main finding was an increase in participation in Triple Iron ultra-triathlons during the 1988-2011 period as has been shown for Double Iron ultra-triathlons (Rüst et al. 2012a). The participation of male athletes in Triple Iron ultra-triathlon increased since the inaugural event in 1988 while the relative participation of female athletes remained stable at ~8%. The rising number of participants is especially obvious where races were held annually like in Lensahn (Germany). The trend of ultra-endurance sports boomed in the late 80's and early 90's (Hoffman et al. 2010; Hoffman and Wegelin 2009; Knechtle et al. 2011a). The limits of ultra-endurance sports were pushed as the length of race distances increased (Lepers et al. 2011). After the first Triple Iron ultra-triathlon held in France, different organisers in other European countries such as Germany and Austria started with these races. In addition, a Triple Iron ultra-triathlon started in North America. The offer of several races worldwide gave more athletes chances to take part in such a race without the hindrance of travelling far especially for North American and European athletes. Most probably, the offer of several Triple Iron ultra-triathlons in Europe compared to only one race in America was a need of European athletes to compete in their continent of origin. Furthermore, it has been reported that most of the athletes taking part in a Double Iron ultra-triathlon also take part in a Triple Iron ultra-triathlon and a Deca Iron ultra-triathlon (Lepers et al. 2011). Double Iron ultra-triathlons have been organised since 1985, first in the USA but then mostly in Europe (Rüst et al. 2012a). The Double Iron ultra-triathlon can be regarded as an ideal preparation for a Triple Iron ultra-triathlon. Both races can be completed without sleeping and at a relatively fast pace (Knechtle et al. 2007; 2008a). However, the number of Triple Iron ultra-triathlons that had taken place around the world was lower than the number of Double Iron ultra-triathlons and the number of athletes who had finished a Triple Iron ultra-triathlon was lower than those who had finished a Double Iron ultra-triathlon (Knechtle et al. 2011a). During the 24-year period,

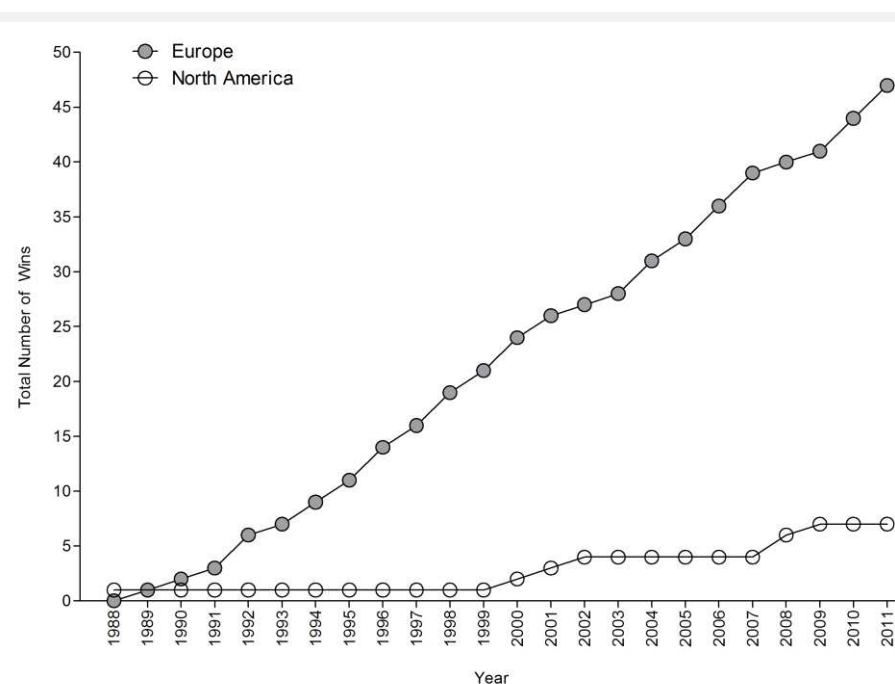


Figure 3. Cumulative number of total race wins (all male) per continent (1988-2011).

Triple Iron ultra-triathlons have been held in seven different places with 1,258 athletes participating. By comparison, Double Iron ultra-triathlons have been held in 20 different places within 25 years, with 1,854 athletes participating (Rüst et al. 2012a).

An aspect for the large offer of Triple Iron ultra-triathlons in Europe and the high participation of European athletes might be the costs. These athletes are all recreational athletes (Knechtle et al. 2011e). The reasons for athletes from Africa, Asia and Australia not taking part in these races are most probably of social and economic nature. The costs for travelling, entry fee and accommodation for an athlete with his/her team might be far too high. While the entry fee in Lensahn (Germany) is 480 Euros (628 US Dollars), the entry fee in Virgina (USA) is 735 US Dollars (561 Euros). The costs for transfer and accommodation will be far higher. Another aspect is the budget of the organizer. The race director from Triple Iron ultra-triathlon in Lensahn (Germany) has a total of 70 sponsors for his single race (www.triathlonlensahn.de); the race director from in Virgina (USA) has 10 sponsors (www.usaultratri.com) for both a Double and a Triple Iron ultra-triathlon.

Performance trends

The second main finding of the present study was the performance of European ultra-triathletes. European athletes won 45 races, while American athletes won the remaining 7 races. This result confirms our hypothesis that European athletes would dominate the Triple Iron ultra-triathlons as they already dominated the Double Iron ultra-triathlons (Rüst et al. 2012a). One explanation is that most of Triple Iron ultra-triathlons and Double Iron ultra-triathlon were held in Europe where the popularity in these ultra-endurance events is greater (Lepers et al. 2011). Lepers et al. (2011) also

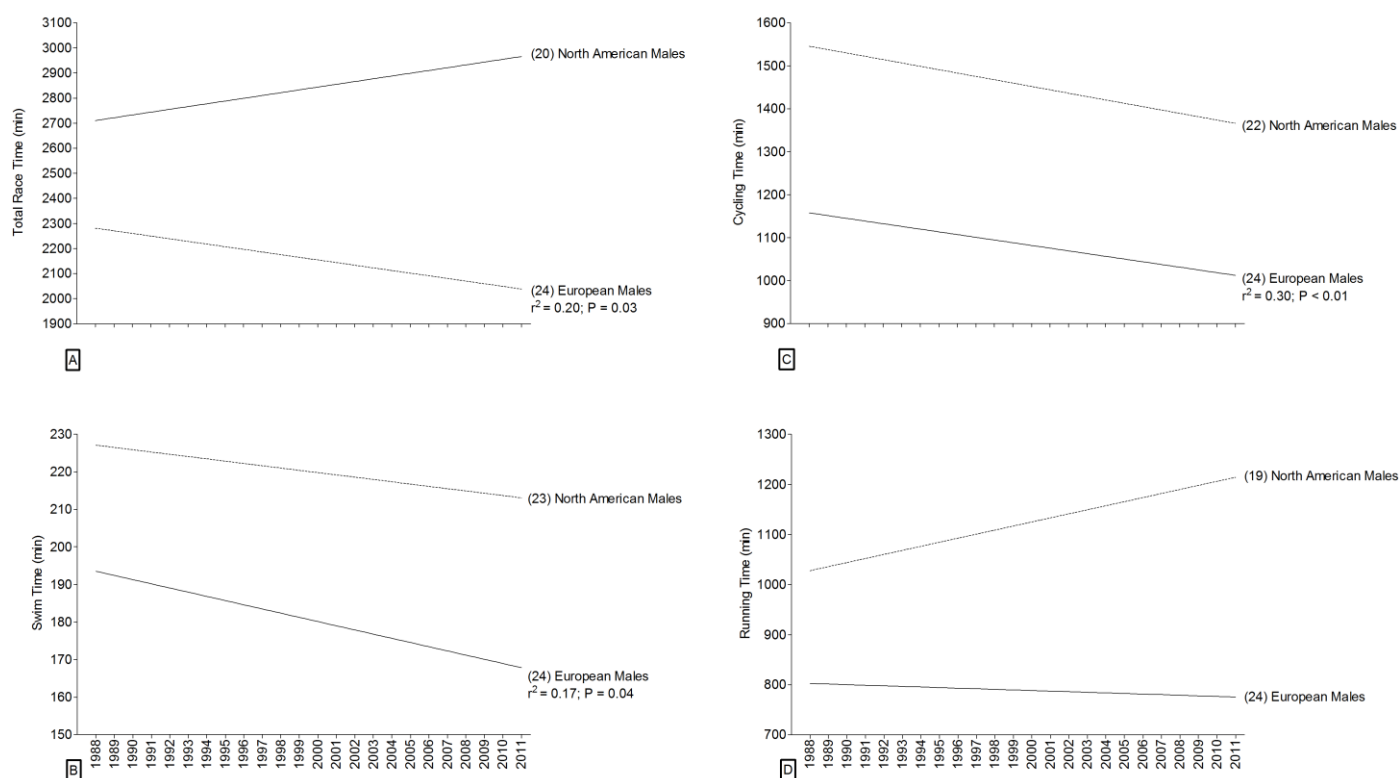


Figure 4. Changes in the best performance (shortest total race or split time) across the years for males from North America and Europe in total time (Panel A), swimming (Panel B), cycling (Panel C) and running (Panel D), respectively. R^2 - and P -values are inserted for groups with a significant change across time ($P < 0.05$).

showed that European athletes represent the majority of participants in Double, Triple and Deca Iron ultra-triathlons. The performance of European males in Triple Iron ultra-triathlon was better than that of North American males. Male European athletes improved their performance in overall race time since 1988, whereas male North American athletes showed no change in their overall performance. Male Europeans improved also both the swim and the bike split, but not the run split. Considering the split times of male North American athletes, their running performance became non-significantly slower. Running has been shown to be a key element of overall performance in a Triple Iron ultra-triathlon (Knechtle et al. 2007; Knechtle and Kohler 2009). Therefore, the male American triathletes did not manage to improve their total race performance. It is also possible that the athletes from North America, who took part in the Triple Iron ultra-triathlon annually, grew older and were past their age of best performance of ~40 years (Knechtle et al. 2011e; Lepers et al. 2012; Stiefel et al. 2012). Overall, the improvements in overall race time and both the swim and cycling split times were rather moderate across years. Most probably, these athletes were all experienced triathletes since previous experience such as the number of finished Triple Iron ultra-triathlons and the personal best time in Triple Iron ultra-triathlon are important predictors for a fast race time in an ultra-triathlon such as Triple Iron ultra-triathlon (Knechtle et al. 2011d) or a Deca Iron ultra-triathlon (Herbst et al. 2011).

Limitations and implications for future research

Due to the cross-sectional design of the study, we were unable to consider aspects of training (Knechtle et al. 2011d), previous experience (Herbst et al. 2011; Knechtle et al. 2011d), anthropometry (Knechtle et al. 2007; 2008a; 2008b; 2011e), fluid metabolism (Knechtle et al. 2010; Rüst et al. 2012b), motivation (Krouse et al. 2011) and race intensity (Knechtle et al. 2008a). Another limiting factor would be the weather (Hoffman and Fogard 2011; Parise and Hoffman 2011; Rüst et al. 2012c; Wegelin and Hoffman 2011). Inclusion of these variables in a multilevel (hierarchical) regression analysis might have affected the results. European athletes dominate Double Iron ultra-triathlon (Rüst et al. 2012a) and Triple Iron ultra-triathlon. A detailed analysis of the participation of European athletes for the different countries might show a specific region of the fastest ultra-triathletes. An analysis of the nationality of the participants at the 'Ironman Hawaii', the 'Ironman World Championship' would reveal whether European triathletes are also able to dominate the Ironman distance. Future studies need to investigate what motivates these athletes to compete in these races.

Conclusion

To summarize, participation in Triple Iron ultra-triathlon increased across years where most of the participants originated from Europe. European males

achieved the fastest overall race times and improved their performance across years.

Acknowledgment

The authors would like to thank the race directors for providing the race results and Mary Miller for her help in translation.

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